MAPPING RANGES OF THE TREES OF THE UNITED STATES

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A MAP is the clearest and most concise method of showing accurately the geographic distribution of a plant species. In comparison the ranges by States given in manuals seem vague and incomplete. Though obviously no more accurate than the original data, a map appears so definite that it may give a false impression. A map correct to minute details would require records from an infinite number of localities.

Botanists, foresters, and other authors bold enough to summarize plant distribution records graphically may expect criticism instead of reward for their efforts. It is far easier to detect a minor flaw along a boundary line than to prepare a better map. The late Professor M. L. Fernald (1950) recently cited a number of inaccuracies in the distribution maps in Preston's North American Trees (1948). (Some of these maps have been revised in the 1950 printing of this book.)

FOREST SERVICE TREE DISTRIBUTION MAPS

The United States Forest Service has long been interested in the distribution of the native trees. George B. Sudworth (1898, 1927), the dendrologist for many years, summarized tree ranges in the two editions of his Check List of Forest Trees of the United States, Their Names and Ranges. Nearly a half century ago he undertook a rather large project of preparing a distribution map for each native tree species of North America, exclusive of those occurring wholly in Mexico. His assistants in a Section of Forest Distribution, chiefly W. H. Lamb, Georgia E. Wharton, and Mary C. Gannett, compiled on separate cards many thousand locality records for individual species, based upon published botanical lists, unpublished notes, and herbarium specimens. For each species these localities were plotted by number on a large cloth-backed contour map of North America.

Publication of these maps was begun by Sudworth (1913) under the title, Forest Atlas—Geographic Distribution of North American Trees. Only Part I—Pines, containing maps for 36

species of *Pinus*, ever appeared. However, some smaller maps of conifers, poplars, tree willows, and walnuts of the Rocky Mountain region were published in five later bulletins by Sudworth. It is unfortunate that the entire atlas, with a map for each native tree species, was not published in 1913 or soon afterwards, when the maps represented current knowledge. Sudworth's maps were compiled in the old days when field work was largely by horse and buggy, horseback, of foot from points along railroads and before the modern era of botanical exploration by automobile travel over networks of highways. Now these old maps are so far out-of-date that their value is chiefly historical.

Munns' Distribution of Important Forest Trees of the United States (1938) consisted of 170 maps, one for each important native tree species. These maps were based largely upon Sudworth's data and more recent data compiled from various publications by William W. Mitchell and others. This publication has been criticized because of various inaccuracies in the maps but was sufficiently popular to be reprinted. Incidentally, some errors noted by Professor Fernald in Preston's book appear to be traceable to these older, Forest Service maps.

Most of Munns' maps were redrafted on a smaller scale and often with slight revisions in the Forest Service series of leaflets known as American Woods, by Betts (1945). Areas of greatest commercial production were shown for several species.

Fairly accurate small distribution maps of many native tree species of the United States can now be prepared from existing published records. My first efforts, 165 small maps, appeared in my article, Important Forest Trees of the United States (Little, 1949a), in Trees, the Yearbook of Agriculture, 1949 (also reprinted as Yearbook Separate No. 2156), and may have been unnoticed by Professor Fernald.

These small yearbook maps were compiled hastily to meet a publication deadline from about 200 published references, supplemented by my own field experience in a few states. Sargent's Manual (1926) and Sudworth's Check List (1927) naturally were consulted, and maps of a few species were found in monographs and special publications. Blake and Atwood's (1942) bibliography of floras was an invaluable aid for location of references and was supplemented for recent titles by the excellent Botanical

Catalog in card form in the United States Department of Agriculture Library. The best publications for tree ranges in every state, chiefly state tree manuals and state floras, were examined. Very helpful published tree distribution maps were found for a few states, such as Illinois, Indiana, Kansas, Nebraska, and Wisconsin. Some local floras were checked, especially in states lacking modern state tree bulletins or floras. Where gaps occurred in the records, vegetation maps (Zon and Shantz, 1924), topographic maps, and a map of the counties in the United States were useful. Lack of time did not permit circulation of preliminary maps to interested critics, search for scattered published notes on range extensions, or examination of herbarium specimens.

Ranges in southern Canada were obtained from maps in Native Trees of Canada by the Canada Dominion Forest Service (1933; also revised in 1949), from Halliday and Brown (1943), and from floras of each province. Distribution in Mexico was not shown because of the limited, scattered published references available. Alaska was omitted, but the few tree species there have been mapped by Hultén (1941–1949).

Some excellent maps of forest types and tree distribution in certain states have been prepared in recent years by the U. S. Forest Service through its Forest Survey. Professor Fernald (1950) criticized Preston's (1948) first map, Forest Regions and Principal Types of Forest in the United States (credited by Preston to the Forest Service), because it did not show the pine forests of New England and New York. The revised Forest Service map of 1949, Areas Characterized by Major Forest Types in the United States, does show these pine forests of New England and New York!

Though most Forest Survey maps illustrate forest types, tree distribution maps of commercial forest trees have been published for a few states; for example, by Roberts and Cruikshank (1941a, 1941b) on North Carolina and South Carolina, by Evans (1942) on Virginia, and by Sternitzke and Duerr (1950) on Mississippi. These accurate maps showing by dots the density of occurrence of merchantable timber, rather than botanical or commercial range, were based upon intensive field surveys and measurements on thousands of uniformly spaced sample plots and upon infi-

nitely more field records than earlier maps. However, some maps of forest resources combined two or more related species having woods not distinguished commercially, such as all species of hickory, all species of ash, or all species of red oaks. Tree species of minor importance were not mapped.

Problems and Methods in Making Tree Distribution Maps

All who have prepared distribution maps of plant species are aware of the problems and difficulties involved. Maps of medium size no larger than an ordinary book page, such as commonly used in taxonomic monographs, probably are best for most purposes where space limits of the publication permit. Small maps, such as those of a field manual, sacrifice detail. However, large maps magnify inaccuracies and may not be better unless their base is also more detailed. As long as the exact limits of many native tree species are not accurately known within as much as 50 to 100 miles in less explored parts of their ranges, large maps are not justified.

The simplest kind of map, commonly employed in taxonomic monographs, is that based upon herbarium specimens, with a dot or other symbol representing each locality of record. This reliable map reveals clearly the supporting data and makes no attempt to fill in the gaps. However, a map limited to specimens shows where collectors have been rather than the various other places where the trees grow. These dot maps are satisfactory for many species of small and inconspicuous plants of interest primarily to specialists. More detailed maps are needed for trees, because of their size, dominance in the vegetation and landscape, economic importance, and widespread public interest.

On a map of a single state, distribution by counties can be shown clearly by a dot in each county of known occurrence. This method is adequate in states with small counties and where much collecting has been done, as illustrated by Gates (1938) in Kansas and Deam (1932) in Indiana. In states with numerous small counties some sight records may be substituted for specimens to save time and labor. Duncan (1950) in Georgia used a special type of card to simplify preparation of maps from sight records. Naturally maps based upon county records alone are

less accurate in the large western States with few counties and diverse topography.

The dot method was applied to the grasses of the United States by Hitchcock (1935; revised 1951) who used a small map of the United States for each species with a dot in each state where the species was known. This graphic summary of occurrence by states in addition to the usual text range might well be adopted by regional floras, including the next edition of Gray's Manual, and is being considered for the less important tree species in the forthcoming Forest Service Check List of the Native and Naturalized Trees of the United States.

Another simple method of mapping distribution is by a line along the species boundaries with one or several species on a map. However, isolated stations and areas within the main range where the species is absent cannot be shown clearly.

One of the best types is a small map of the United States on which distribution of a tree species is indicated by a dotted or stippled area. Dots are more natural than a line because the range limit is not a sharp line. If every tree were shown on a large scale map of a small area, the map would usually consist of dots with a border of scattered dots. Authors adopting this type for trees include: Hough (1907), Seton (1912), Mathews (1915), Preston (1940, 1948), Jacques (1940), Harlow and Harrar (1941), and Little (1949a).

Where two colors are permitted the range can be shown by a colored overlay on a black and white base map containing locality details. For example, a solid green overlay was used by Sudworth (1913 and later publications), Benson and Darrow (1945), and the Canada Dominion Forest Service (1949).

It is not easy to transfer the distribution limits of a tree species to a map, even after field observations. Inconspicuous individuals may be scattered many miles beyond the boundary of a certain forest type. On a small scale map outlying stations must be exaggerated, consolidated, or omitted because of cartological difficulties. Different persons using the same data might not compile identical maps. Boundaries of range in publications of adjacent states sometimes do not coincide. Minute details of some maps, such as restriction of certain species of moist sites to strips along the larger streams, tracing of boundaries exactly

from contour lines in mountains, and irregular dotted masses near range limits, imply an accuracy probably unwarranted by the basic data.

The distribution of several native tree species is complicated by cultivation, escaping, and naturalization beyond the original ranges. Where records are sufficient both the native and naturalized ranges should be distinguished on the same map. Other species may have become extinct in isolated stations or small portions of their natural range through destruction of habitats or cutting. Regions where exotic species or native species can be cultivated may be summarized by reference to numbered zones on a base map of the United States. Mulford's map of plant growth regions of the United States was adopted by Van Dersal (1938) for the ranges of native woody plants. Maps of hardiness zones based upon average annual minimum temperatures have been used by Rehder (1927), Little (1949b), and others.

Ordinarily density or abundance is not indicated on tree distribution maps except those based upon forest surveys. However, published maps of forest types or vegetation show distribution of the dominant tree species and indirectly the areas of greatest economic occurrence except on the vast areas where the forests have been destroyed.

FUTURE WORK

An atlas showing the distribution of each native tree species in the United States is still needed, and further delays may increase the difficulties of mapping.[1] The U. S. Forest Service, which had no dendrologist after Sudworth's death in 1927 until 1942, is the logical center for this work. As Sudworth (1913) remarked, the cooperation of many persons is needed, because no one can hope to accomplish this task from his own observations alone. During the next few years and with the assistance of Forest Service field personnel and others, I plan to compile distribution maps of each native tree species in the United States on a medium scale for publication in a single volume. The preliminary maps can be

[1] Useful, generalized distribution maps of the tree species of temperate North America and Eurasia, excluding small and shrubby trees, have been published by Theodor Schmucker (The Tree Species of the Northern Temperate Zone and Their distribution. Silva Orbis No. 4, 156 pp., illus. 1942). However, the 250 small-scale maps showing species boundaries by lines of different kinds lacked country and state boundaries and were below the desired standards of accuracy.

circulated in advance to a limited number of interested persons for revision. Of course, the published maps will be available to all who wish to use them, such as writers of tree books, just as Forest Service photographs and drawings of trees now are.

Suggestions and information for this project will be welcome. Instead of condemning further the inaccurate tree distribution maps already published, those interested should help make better ones. The greatest need now is for more articles or bulletins devoted to distribution maps of native tree species in a single state and prepared by an experienced resident botanist or forester. Published tree distribution records of some states still are rather meager and insufficient for plotting. Botanists and foresters are urged to publish at an early date articles containing their records on range extensions of trees from their collections, herbaria, or observations. (I should be very glad to receive reprints.) Duplicate specimens confirming these records should be deposited in one or more large herbaria as well as in the state or institution herbarium.

Corrections and range extensions of the 165 small maps in my yearbook article are welcome, as mentioned on page 764. I shall be glad to send two copies of Yearbook Separate No. 2156 to any interested persons who will be kind enough to return one copy with any corrections and range extensions marked on the maps with colored pencil (or shown on larger maps). (Yearbook Separate No. 2156 is also for sale by the Superintendent of Documents, Washington 25, D. C., at 15 cents a copy.)

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Washington 25, D. C.

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CHROMOSOMES OF SPIRAEA AND OF CERTAIN OTHER GENERA OF ROSACEAE

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Chromosome numbers determined for various American—and one introduced—representatives of Rosaceae are recorded in Table I. Only plants of known geographic source are included. Counts were readily made from leaf smears. Diploid, tetraploid, and hexaploid expressions of a 9-series were found. Species previously in the chromosomal literature are discussed; others are merely listed in the table. Specimens collected by the author and cited are in the herbaria of U. S. National Arboretum and of the Smithsonian Institution. Those collected by Clover and Jotter are in the Herbarium of the University of Michigan.

Spiraea

Spiraea, a genus of about fifty species in the temperate zone of the northern hemisphere (Willis, 1948), is, of course, an assemblage of considerable horticultural importance. The relatively